HexSim: A flexible simulation model for forecasting wildlife responses to multiple interacting stressors

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Abstract

With SERDP funding, we have improved upon a popular life history simulator (PATCH), and in doing so produced a powerful new forecasting tool (HexSim). PATCH, our starting point, was spatially explicit and individual-based, and was useful for evaluating a range of terrestrial life histories, landscapes, and disturbance regimes. But PATCH had significant limitations. It was a single-population females-only model whose individuals were all identical. It had a modern but cumbersome interface, and it could not capture stressor interactions. These limitations compromised the model's realism and utility. In constructing HexSim from PATCH we have relaxed these and many other constraints; HexSim is a true multi-population and multi-stressor program. In addition, HexSim's populations are trait-based, which means individuals can have unique and dynamic properties. Traits can be genetic, probabilistic, or experiential in nature, and they can influence individual vital rates and behaviors. This poster will illustrate the design, features and use of the new (and freely available) HexSim model.

Background

Our proposal to SERDP involved two principal activities:

1. Construction of a new individual-based and spatially-explicit population model (SEPM)
2. Application of the model to three case studies on DOD installations (see posters 89 and 90).

To accomplish part 1, the construction of a new SEPM, we argued for the development of a series of extensions to an existing model (PATCH, constructed at the EPA). Specifically, we promised to add modules to PATCH that made it possible to:

A. Model complex interactions among stressors
B. Model interspecific interactions
C. More easily interact with the model

Approach

Working in collaboration, EPA and UW staff converted the PATCH model into a state of the art population simulator that is flexible, powerful, modern, and easy to use. The result of this work is HexSim. Version 2.0 of HexSim, our final product, will be completed and made available to SERDP (and the public) in the first quarter of 2010. In March, 2010 we will hold a full day HexSim workshop to complete the Tech Transfer part of our SERDP project.
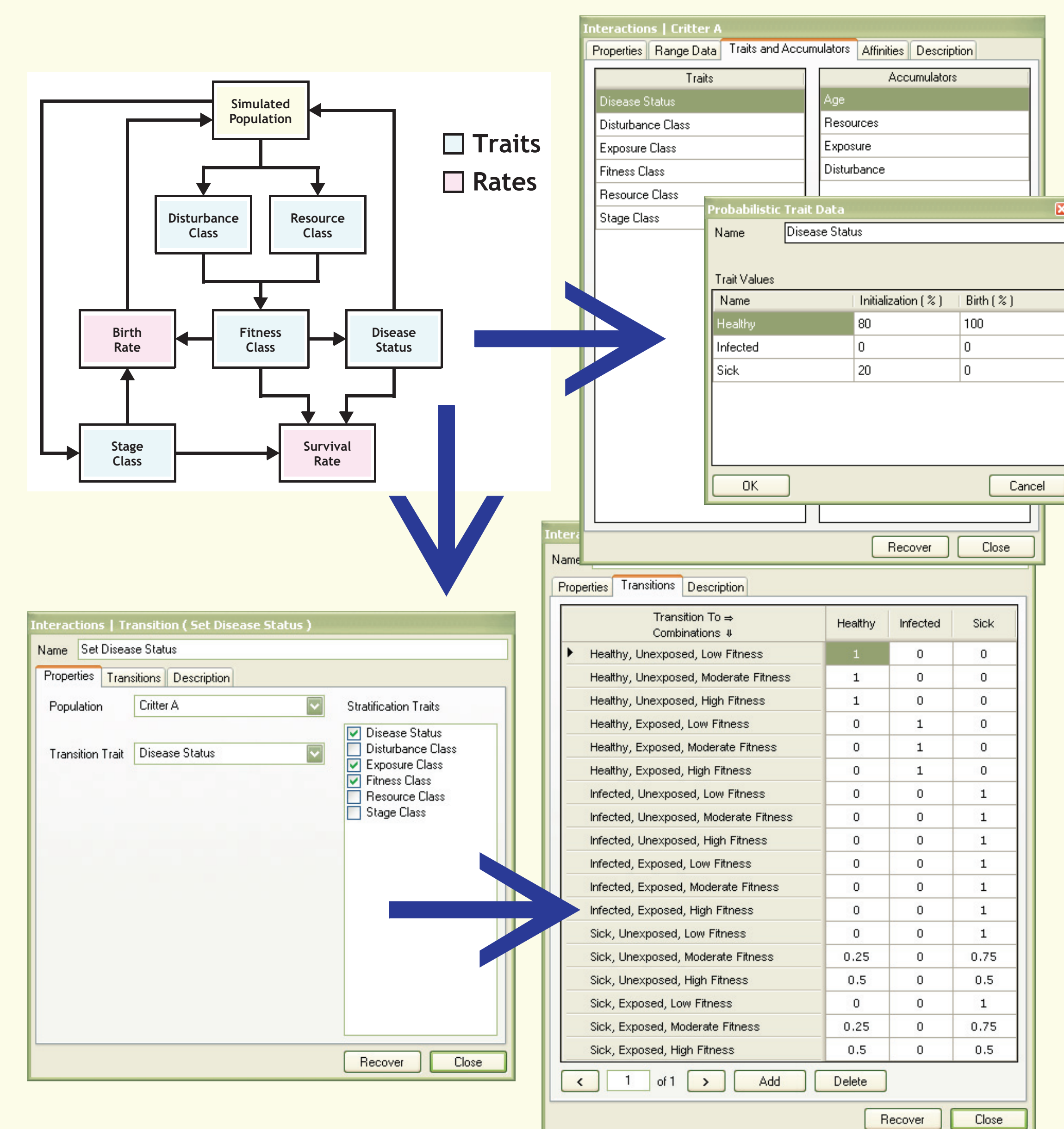

Technical Approach
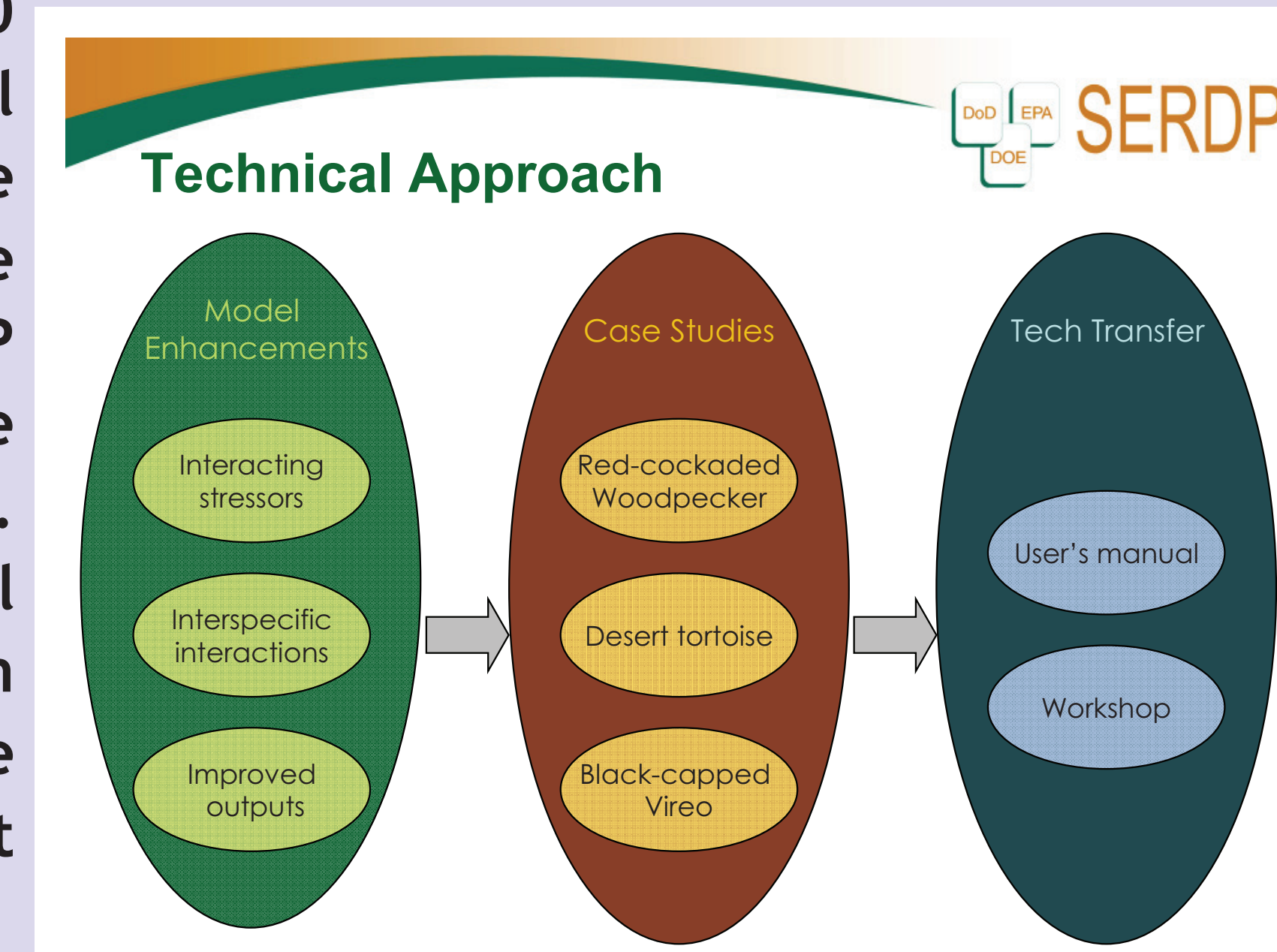
HexSim Basics
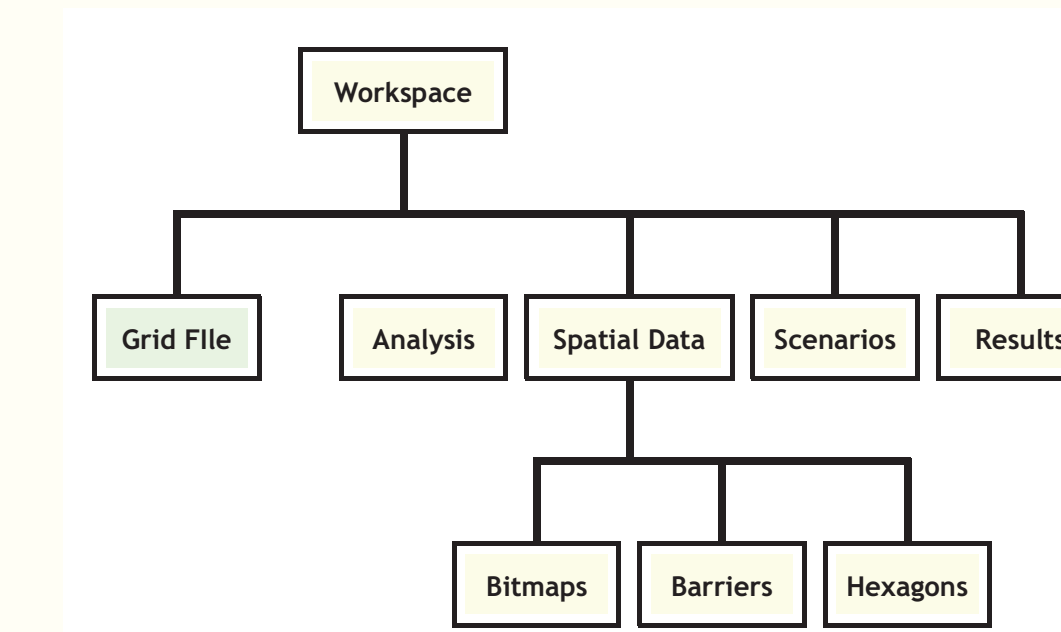
HexSim is a spatially-explicit, individual-based model that simulates terrestrial wildlife population dynamics and interactions. Simulations are based upon a user-defined life cycle. Individual behavior and experience are captured using a flexible trait scheme.
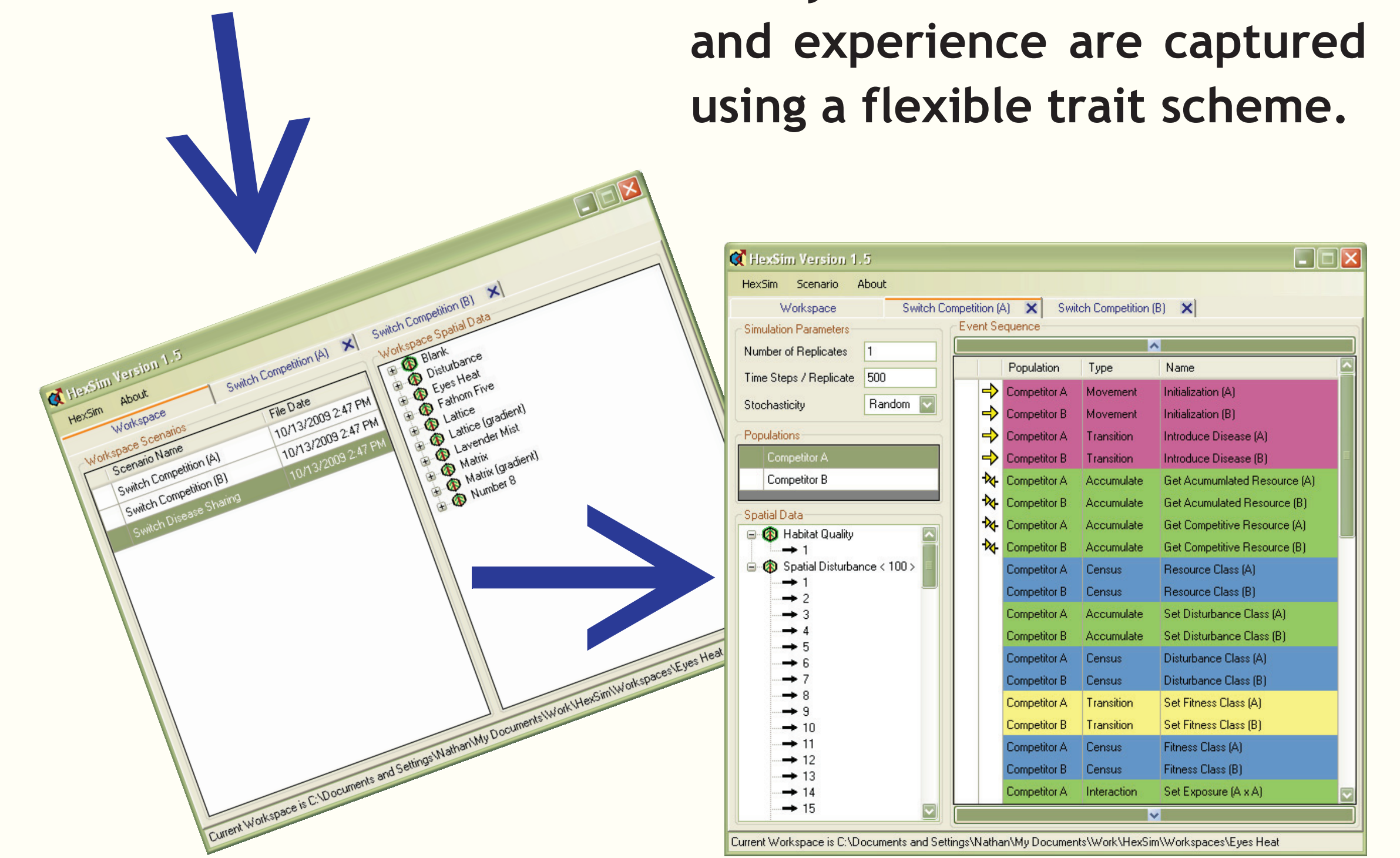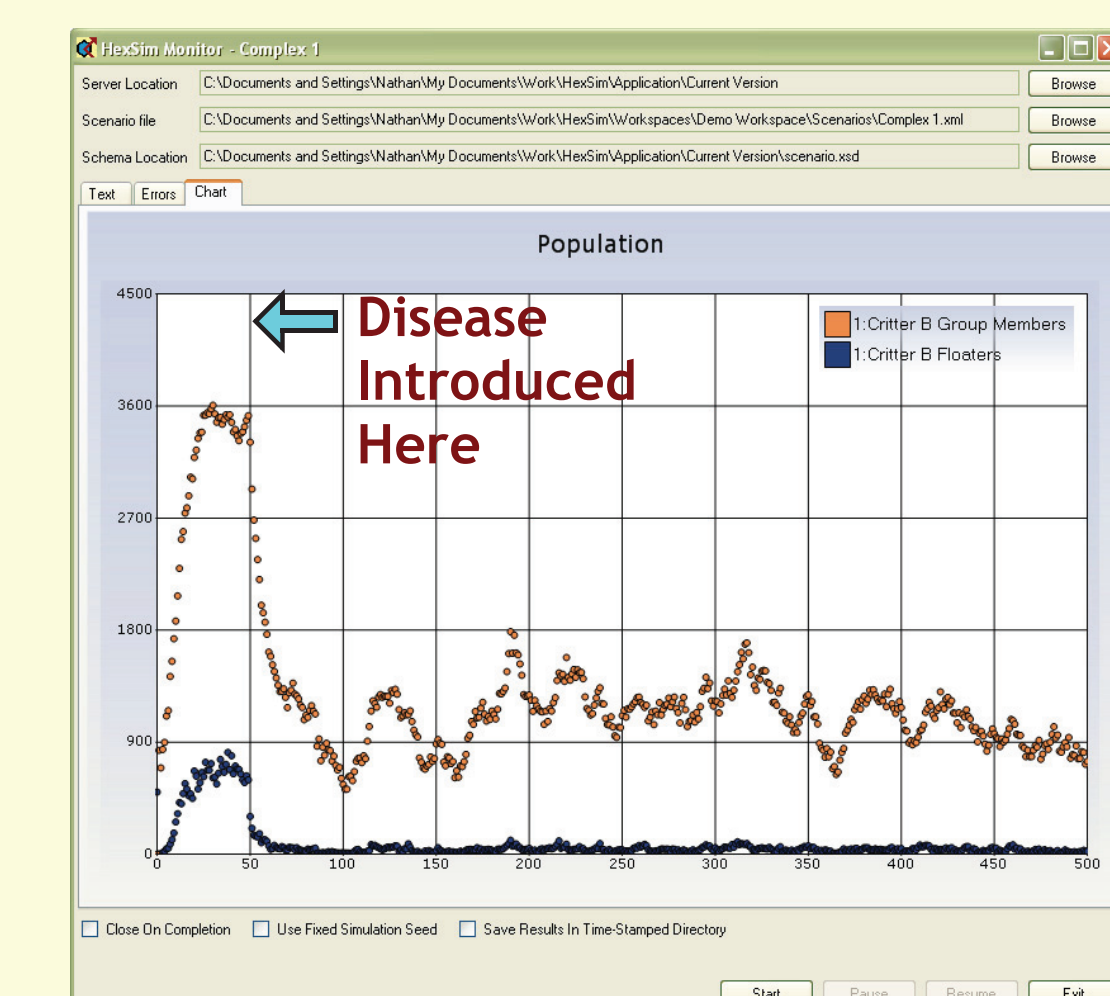

Traits (an example)
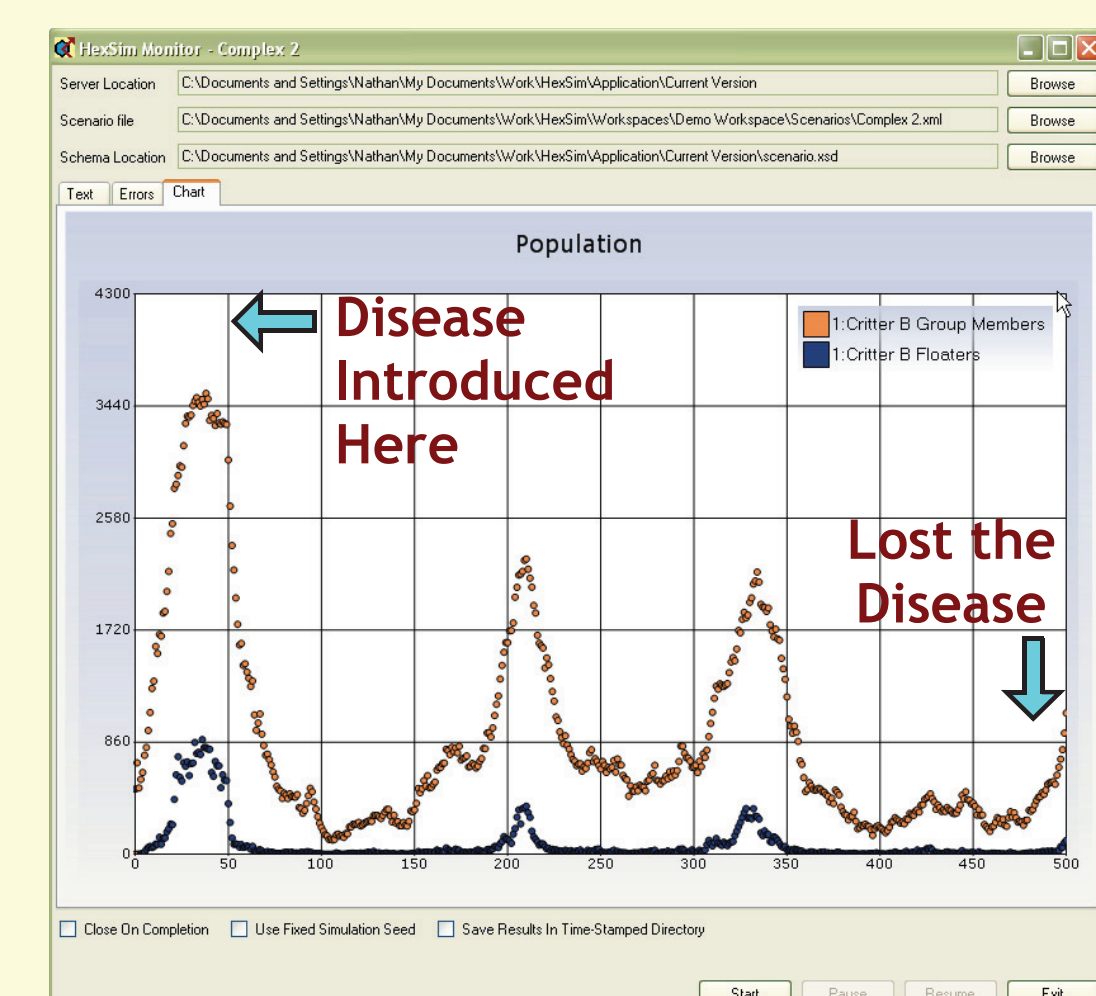

- ☐ Traits
- ☐ Rates

Interactions

HexSim can be used to simulate both stressor and population interactions. Stressor interactions can be simple or quite complex, and can be fully integrated into all aspects of the life cycle. Population interactions may be intra- and inter-specific, and can be designed so that they result in a wide variety of outcomes.
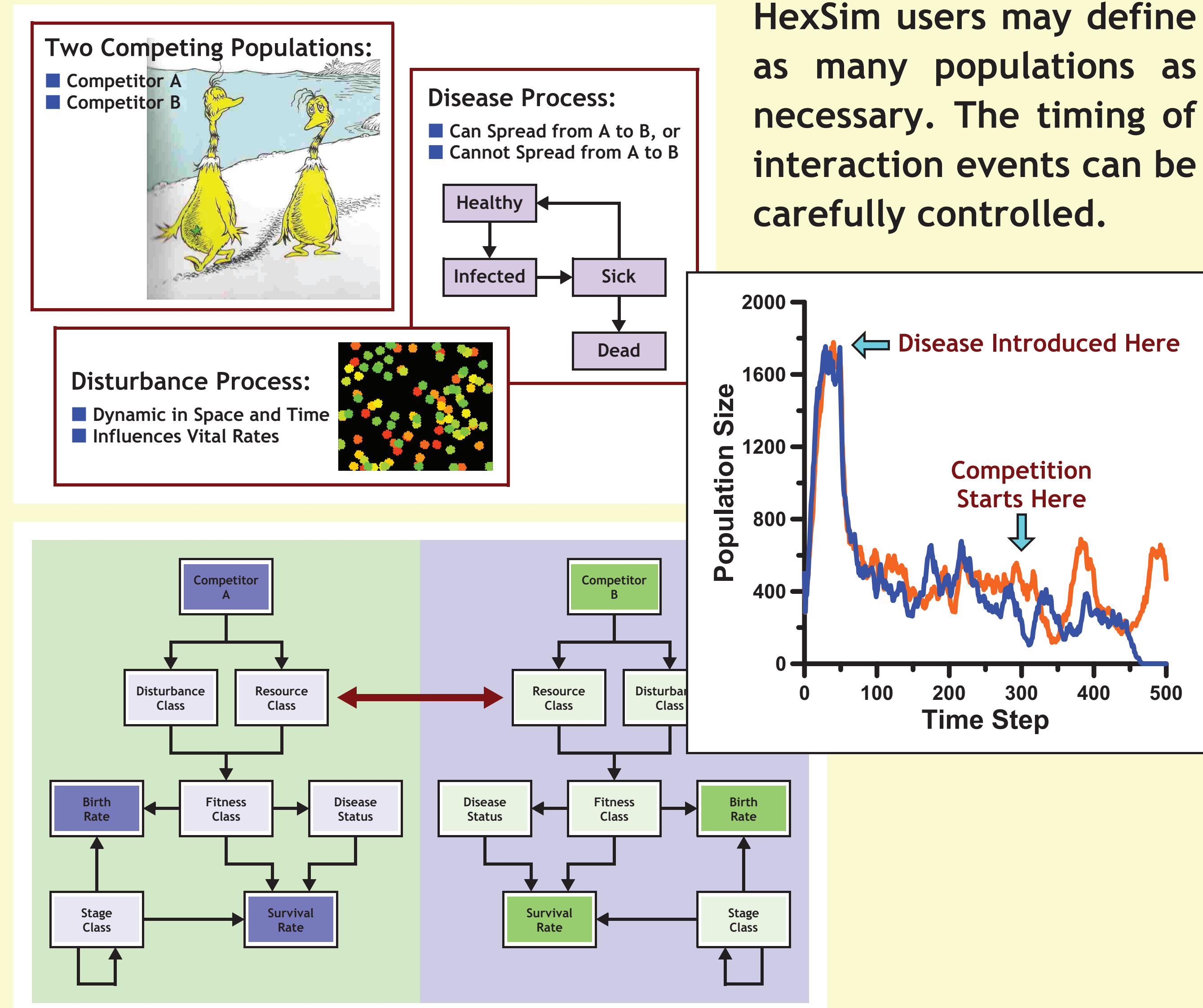

Dynamic Spatial Disturbance **Off**   Dynamic Spatial Disturbance **On**

Populations

HexSim users may define as many populations as necessary. The timing of interaction events can be carefully controlled.

Two Competing Populations:
- ■ Competitor A
- ■ Competitor B

Disease Process:
- ■ Can Spread from A to B, or Cannot Spread from A to B

Disturbance Process:
- ■ Dynamic in Space and Time
- ■ Influences Vital Rates

Usability and Reports

As part of our SERDP project, we have developed a modern sophisticated GUI for the HexSim model. Users can now easily generate a wide array of tabular and map-based output products and animated movies of simulation dynamics. HexSim 2.0 will be delivered with integrated context-sensitive documentation and a set of worked examples designed to help users become familiar with its use and range of applications.

Acknowledgements